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ABSORPTION OF THE D-LAYER AND TEMPERATURE OF THE MESOSPHERE *

Comptes-Rendus de
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T. 256 , No. 21, pp.4491 - 3,
Paris, 20 May 1963

by MM. Mario Bossolasco
and Antonio Elena

Our current state of knowledge of the wintertime anomalous ionospheric absorption can be summarized as follows :

1) The absorption excess on the anomalous days is of the non-deflective" type and seems due to the lowest part of the D-layer [1].

2) Even in the anomalous days there is a clear variation according to local time, but this diurnal variation does not follow up the cos χ law, since the absorption already reaches its maximum at 10 00 hours, or nearly so, and remains practically constant till some hours of the afternoon [1].

3) The wintertime anomalous absorption phenomenon is observed generally only at middle latitudes; the geographic correlation is then positive between the stations having about the same longitude, while it is negative between stations differing consuderably in longitude [2].

4) The correlation between the anomalous absorption and the magnetic activity is significative only if one considers the long-period variations corresponding to the solar activity cycle [2].

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* Absorption de la couche D et température de la mésosphere. -

A satisfactory theory of the phenomenon should explain all that. However, it has not been given yet, but it was assumed that the ionization extraordinary of the D-layer (which is responsible for the anomalous absorption) can result from the effect of a micrometeoric dust flux [1]. On the other hand, Gregory [3] had observed at Christchurch (N. Z.) echoes om 1.75 Mc/s, bounced by the mesosphere, whereas Dieminger [4] already had advanced the hypothesis that partial echoes of such type could be due to meteorological phenomena in the lower ionosphere.

The synoptic, study of the meteorology of the mesosphere has begun during the past few years [5]. It was found in particular, that the rapid temperature increase of the upper stratosphere should be ascribed to extraterrestrial causes [5]; and that there exists a correlation between the long-period variations of the geomagnetic activity and those of the temperature of the upper stratosphere [6]. At any rate, Craig and Lateef [7] have shown how the rapid heatings of the stratosphere correspond to changes in the vertical notions in the same region.

We habe searched in that context, whether or not there exists a relation between the anomalous ionospheric absorption and the thermal conditions of the lower mesosphere. Considering the two winters of 1958-1959 and 1960 - 1961, we utilized the mean values of the ionospheric absorption registered around noon at Friburg-en Brisgau (Germany, 48° N), with waves emitted in the following frequencies : 1.725, 2.05, 2.44 and 2.90 Mc/s, which at vertical incidence are reflected by the E-layer. The value in decibels of the absorption L has been expressed by the index A of the non-deflective absorption by means of the well known formula $A = L(f + f_1)^2$, where f is the sounding frequency and f_1 is the longitudinal component of the gyrofrequency. This index' A slipping medians from 7 to 7 consecutive days for Fribourg, reduced to the average of the four indicated frequencies, have permitted to plot graphically the pattern of the ionospheric absorption for the two winters of 1958-9 and 1960-1961. (see Fig. 1 next page).

[redacted]

We have also reporduced in the same Figure the corresponding values of the mean temperature at 10 mbar over Central Europe (between 5 and 20^{o} long.E and 45 - 55^{o} lat.N as an average), derived from the Tagliche Hohenkarten in the Meteorologische Abhandlung of the Institute of Meteorlogy and Geophysics of the Berlin University.

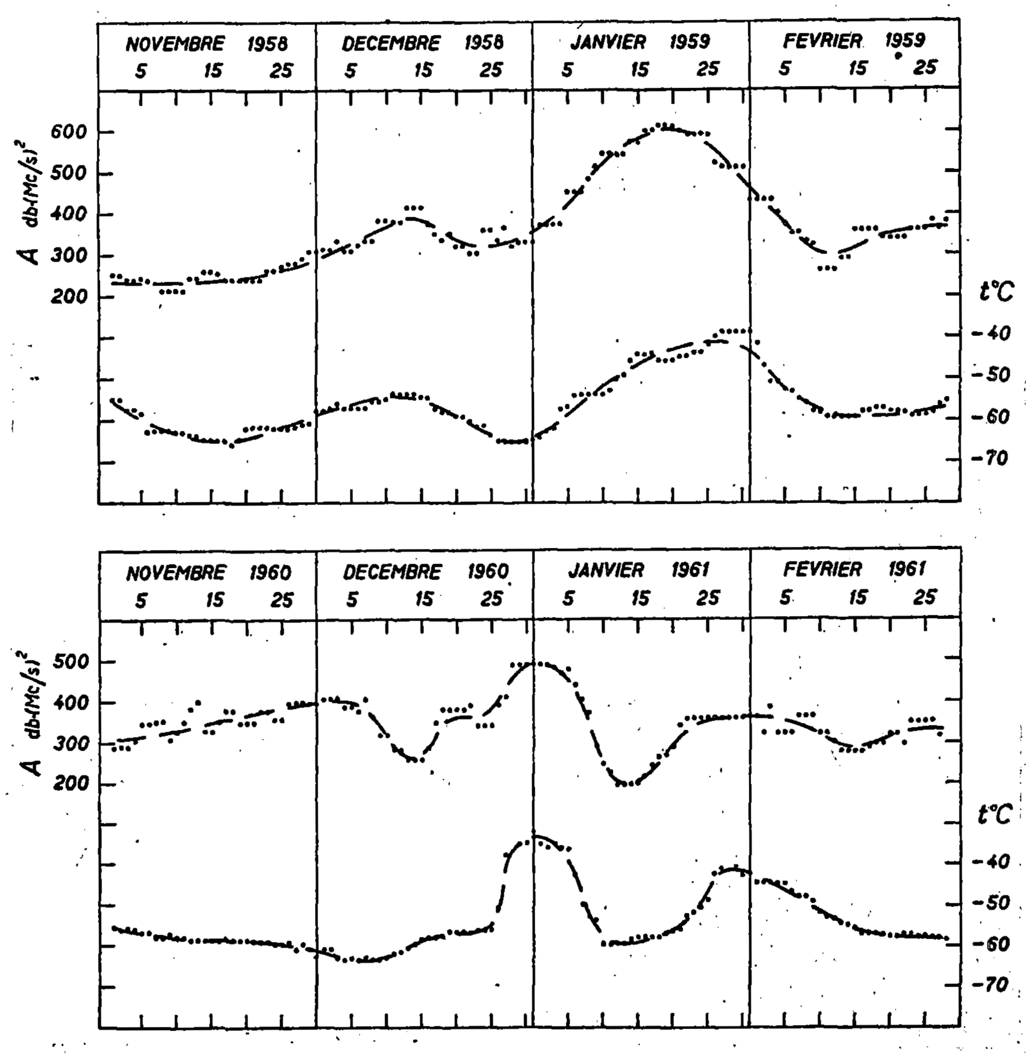

Fig. 1

The above Figure shows that there is a close correspondence between the strong heatings of the lower mesosphere and the ionospheric absorption, the maxima of the two phenomena taking place at nearly the same days.

The correlation coefficient, computed according to Rawer method, gives the value of $+0.82$ during the first winter (Nov.1958-Feb.1959), while for the other winter (Nov.1960-Feb.1961) it is of only $+0.37$. As is shown by the Figure, the smallness of this last value is explained by the feeble variations of short period that were perceived during the second winter, whereas during the first one they had scarcely taken place.

The revealed correlation between these two phenomena can be viewed as reliable and narrow for the rapid and intense variations.

As to the few phase differences between the corresponding maxima, it seems, judging from the Figure and though the data are still insufficient, that in the majority of cases an anticipation of the ionospheric phenomenon relative to the thermal one of the lower mesosphere exists, fact which would confirm the extraterrestrial origin of the common cause of these two phenomena.

During the winter the periods of strong heating of the mesosphere are thus characterized by an anomalous ionospheric absorption at middle latitudes. The propagation of the ionization responsible for these phenomena can explain the negative correlation between stations very remote in longitude. Indeed, the ionization of the D-layer is mostly due to the Lyman- radiation (1215.7 Å) which is the predominant line in the solar ultraviolet spectrum and which produces the ionization of NO. Consequently, the motions in the upper atmosphere have an effect on the production and transport of NO, thus causing ondulatory variations of the electron density.

The detailed study of the phase differences between the pattern of ionospheric absorption and of that of the temperature of the lower mesosphere, seems to allow the extension of our knowledge on the dynamics of the upper atmosphere.

*** THE END ***

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